No one, in America at least, has been more roundly denounced by them, yet this denunciation, it may be mentioned incidentally, results in making him all the more cheerful. No earnest and unprejudiced seeker after the truth can turn from the perusal of this book without a feeling of disgust at the iniquitous kind of warfare that has been waged by the enemies of progress and without a keen recognition of the utter feebleness of their attitude. In relentlessly exposing them Dr. Keen deserves the gratitude of all men and women who love truth and humanity.

Frederic S. Lee
Columbia University

An Introduction to the Study of Physical Metallurgy. By Walter Rosenhain, B.A., D.Sc., F.R.S. New York: Van Nostrand Company. 390 pages, 6 × 9. Illustrated. Net $3.50.

The book is divided into two parts, the first section dealing with the structure and constitution of metals and alloys, the second with the properties of metals as related to their structure and constitution.

Taking up first of all the microscopic examination of metals, the author discusses the preparation of specimens, and the microscope used, then the microstructure of pure metals and alloys. This is followed by the thermal study of metals and alloys, the thermal diagram and its relation to the physical properties. Typical alloy systems are exemplified by the lead-antimony, lead-tin, zinc-aluminium, zinc-copper, tin-copper and certain ternary alloys, followed by the iron-carbon system.

The second part first reviews the mechanical testing of metals, the effect of strain on the structure, heat treatment, mechanical treatment and casting, and ends with a discussion of defects and failures.

To review the contents of this book thoroughly would take many pages, because the author has covered the broad field of metallography so thoroughly and so well. This is particularly true of the presentation of the comparatively new ideas on the structure of metals, the effects of strain and of annealing, developed from Beilby's amorphous metal theory. The elongation of the crystals when strained, the production of slip-bands and their nature, the formation of amorphous layers and the hardening of metals by cold work, twin structure, fracture under tensile, shock and alternating stress conditions, the amorphous cement theory, are all most clearly set forth. The criticisms therefore must be on minor points and not on the broad lines of the book.

For example, on page 13, after mentioning the names of the earlier workers, Sorby, Martens, Osmond, Werth, Grenet, Charpy, Le Chatelier, Heyn, Wüst, Tammann, Andrews, Arnold, Roberts-Austen, Stead, Howe and Sauveur, the author says: "The fact that the present author was privileged to count Roberts-Austen and Osmond amongst his personal friends, and that Arnold and Stead are still actively at work in this field, serves to show how very recent the whole development has been." Besides Arnold and Stead, many of those mentioned are "still actively at work" as current literature in the metallographic field amply proves.

On page 21, in describing the preparation of specimens for polishing, "the necessity of gripping the specimen in the vise" to file it is mentioned. Most people grip the file in the vise and rub the surface of the specimen on it.

On page 31, the reference to etching reagents is too short and might with advantage be expanded.

On page 162, as Ruff's work is mentioned, reference ought also be made to that of Wittorf and of Hanemann.

The photomicrographs are all well chosen and excellently executed, but lose somewhat in not having a title beneath each, rather than in the list of plates.

In conclusion, the only change that could be suggested is in the section on the thermal diagram which should contain those diagrams showing partial solubility in the liquid state. A short classification according to solubility in both liquid solid states would help.

The author has succeeded in preparing an excellent book, interesting to the student, valuable to the metallurgist and engineer, and full of ideas for any one engaged in metallographic research. It is a book that can be

recommended to the general reader also, because the style is simple and the ideas are clearly and logically developed and followed. With the growing interest in metallography as a method of testing and of research it will undoubtedly prove very popular.

W. CAMPBELL

SPECIAL ARTICLES

THE TEMPORAL FOSSÆ OF VERTEBRATES IN RELATION TO THE JAW MUSCLES

ABOUT two years ago one of us (Gregory) discovered that the superior and lateral temporal fenestræ of all two-arched reptiles and the single fenestra of all one-arched reptiles appear to be related to the jaw muscles in such a way that they either give exit to them upon the top of the skull or afford room for them at the sides. It was afterward learned that Dollo[1] had reached the same conclusion in 1884, but his important results have been practically ignored in the subsequent literature of the temporal fenestræ, which have been considered too largely from a purely taxonomic viewpoint and too little with reference to their adaptational significance.[2]

More in detail, the steps leading to the present note were chiefly as follows:

It was observed that the temporal fossæ of *Cynognathus* and other Theriodonts present close resemblances to those of primitive mammals and it thus seemed highly probable that in these reptiles the sagittal and occipital crests, together with the zygomatic and postorbital borders, bounded the homologue of the mammalian temporalis muscle. Comparison with the snapping turtle *Chelydra* suggested that in this case also the backwardly prolonged sagittal crest served for the attachment of the temporalis; and this gave added significance to the immense temporal fossæ and massive mandible of *Chelone*. The partial excavation of the dorsal roof over the temporal muscles in *Chelydra* appeared to give this muscle more room for action, and the almost complete removal of the temporal roof in *Trionyx* seemed to give further evidence in the same direction.

In *Sphenodon* it was seen that the borders of the superior temporal fenestræ apparently served for muscle attachment, and dissection of a specimen of this animal showed that this inference was correct, and that the lateral temporal fenestræ gave room for the expansion and contraction of the voluminous muscle mass. It was further recalled that in the most primitive Tetrapoda (stegocephalians and cotylosaurs) as well as in primitive Osteichthyes (*Polypterus,* Devonian Rhipidistia, Dipnoi, etc.) the temporal region is completely roofed over, while modernized forms such as Urodeles, Anura, lizards and snakes have the outer temporal roof reduced to slender bars or even entirely absent. The presence of a sagittal crest in *Amphiuma* indicated that in the modernized Urodeles the temporal muscles had extended on to the top of the skull. From such observations the following inferences were drawn:

1. That in primitive vertebrates the chief temporal muscle-mass (adductor mandibulæ of sharks) was originally covered by the dermal temporal skull-roof.

2. That in modernized Amphibia and Reptilia, as well as in birds and mammals, one or more slips of the primitive adductor mass had secured additional room for expansion by perforating the temporal roof either at the top or at the sides or in both regions at once; much as in hystricomorph rodents a slip of the masseter has invaded the region of the infraorbital foramen, so that it now extends through a widely open arcade and finds room for expansion on the side of the face.

3. A comparative study of the skull of *Tyrannosaurus,*[3] in connection with the abovementioned observations and conclusions, led to the suspicion that the antorbital fenestræ of

[1] "Les Muscles éleveurs de la Mandibule et leur Influence sur la Forme du Crâne: Cinquième Note sur les Dinosauriens de Bernissart," *Bull. Mus. Roy. Hist. Nat. Belg.,* Tome III., 1884, pp. 136–146.

[2] A partial exception to this statement is afforded by Professor Lull's well-studied reconstruction of the cranial musculature of *Triceratops* (*Amer. Jour. Sci.,* Vol. XXV., 1908, pp. 387–99).

[3] Partly embodied in Professor Osborn's memoir on *Tyrannosaurus, Mem. Amer. Mus. Nat. Hist.,* N. S., 1912, Vol. I., Pt. I.